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A POSSIBLE METHOD OF RECORDING AND REPLAYING VIDEO WITH SOUND-IN-SYNCS ON VIDEO TAPE RECORDERS

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Summary

A method of recording and replaying a video signal with sound-in-syncs has been proposed and experimental equipment has been constructed to investigate the proposed method, with encouraging results. Tests showed the method to be feasible, but more work on error-detection and error-correction would be required before a practical system could be constructed for general use. It is likely that, with such protection, a separate high-quality sound channel could be accommodated on video-tape recorders without detriment to the video signal.

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A POSSIBLE METHOD OF RECORDING AND REPLAYING VIDEO WITH SOUND-IN-SYNCS ON VIDEO TAPE RECORDERS

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1. Introduction

For some time now, the Sound-in-Syncs (S-i-S) system[1] for transmitting a sound channel digitally within a video signal has been used on links between studio centres and television transmitters. The combination of sound and vision signals simplifies point-to-point signal routing and provides a high-quality sound channel over long paths.

Some advantages could also be obtained from recording and replaying a video signal complete with S-i-S; for example, an additional, high-quality sound channel would be made available (although separate editing of sound and vision would not be practicable) and the direct recording of signals from remote sources would be simplified in that it would not be necessary to construct equipment to decode or erase the S-i-S before recording.

There are two alternative requirements of any system performing the above functions: either

(a) to record video with S-i-S signals, recovering the complete signal (or recovering video and the S-i-S signals separately) on replay; this includes using S-i-S as a separate high-quality audio channel.

or

(b) to record video with S-i-S signals, recovering only the video signal on replay.

The operation of video tape recorders depends upon the duration and shape of the television line synchronising-pulse and any signal in, or near, the synchronising-pulse may cause malfunction of the recorder. For example, some of the video processing circuits associated with a typical recorder clamp the video signal during the periods occupied by the tips of the synchronising-pulses; they also perform switching and blanking operations during or near these intervals, and may insert regenerated synchronising-pulses when replaying. Thus, there are several ways in which the S-i-S pulses would themselves be distorted, or removed, or would interfere with the normal operation of the recorder.

2. The typical quadruplex video tape recorder

A preliminary examination of the circuit diagrams of a typical video tape recorder showed that several circuits would be affected by S-i-S, while others would distort the S-i-S pulses.

Figs. 1 and 2 are block diagrams of a typical quadruplex video tape recorder illustrating the equipment involved in both recording and replaying.

An initial test showed that the presence of S-i-S pulses in the video signal disrupted the normal operation of the recorder in several respects.

2.1 Circuits found to be affected by S-i-S pulses

2.1.1 Clamp-pulse generator

Clamping-pulses are generated from the trailing edges of synchronising-pulses; S-i-S pulses upset the timing of these pulses.

2.1.2 Switching logic

This unit derives head-switching control pulses and clamping-pulses from the leading edges of line-synchronising pulses; S-i-S pulses can cause multiple triggering of the logic circuits.

2.1.3 Luminance timing corrector

This unit derives clamping-pulses and timing-comparison drive-pulses from the leading edges of line-synchronising pulses; clamping is timed to take place during the tips of the line-synchronising pulses (i.e. at the time of S-i-S pulses). Thus S-i-S pulses cause both faulty clamping and errors in signal timing.

2.1.4 Chrominance timing corrector

Using the trailing edges of line-synchronising pulses, this unit derives pulses that drive the 7·8 kHz V-axis PAL switching circuits; S-i-S pulses were found to affect this operation.

2.1.5 Processing amplifier

Clamp-pulses are derived from the leading edges of line-synchronising pulses, and their timing was found to be disturbed by the presence of S-i-S pulses.

2.2 Circuits likely to affect S-i-S pulses

2.2.1 Luminance timing corrector

Clamping of the video signal is timed to occur during the tips of the line-synchronising pulses and this results in distortion of the S-i-S pulses. The timing-corrector operation involves line-by-line changes in the value of a video delay and each change takes place at the same time that a line-synchronising pulse and the S-i-S pulses would be traversing the delay, resulting in further gross distortion of the S-i-S pulses.

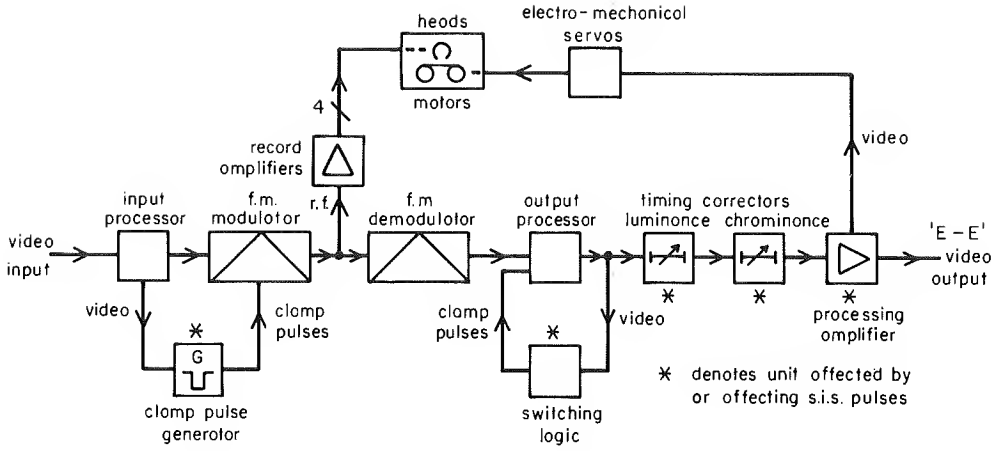

Fig. 1 - Typical quadruplex videotape recorder in the 'record' mode

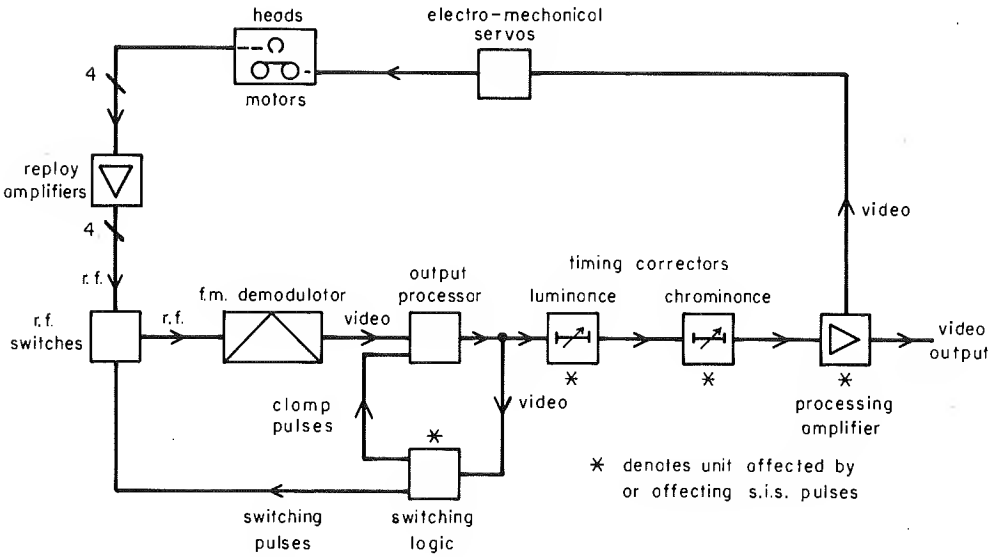

Fig. 2 - Typical quadruplex videotape recorder in the 'replay' mode

2.2.2 Processing amplifier

The normal blanking operation carried out by this unit would completely remove the S-i-S pulses. Furthermore, the circuits for separating and recombing the video and synchronising-pulse signals would severely distort the S-i-S pulses.

3. Principle of the method adopted for recording and replaying S-I-S

It can be seen from Figs. 1 and 2 that all the circuits (except the clamp pulse generator) likely to affect or be affected by S-i-S pulses are fed with signals through the Output Processor. Separation of the signal into its video and S-i-S components at the Output Processor, therefore, allows for separate handling of the two signals and, thus, most of the problems involved in recording and replaying S-i-S can be 'by-passed'. The exception to this rule is the clamp-pulse generator associated with the recording circuits which must be fed with synchronising-pulses derived from a specially designed synchronising-pulse separator.

Fig. 3 is a block diagram of a typical quadruplex-head video-tape recorder, incorporation these modifications,*

*It is probable that the method described will work satisfactorily on most, if not all, quadruplex video tape recorders.

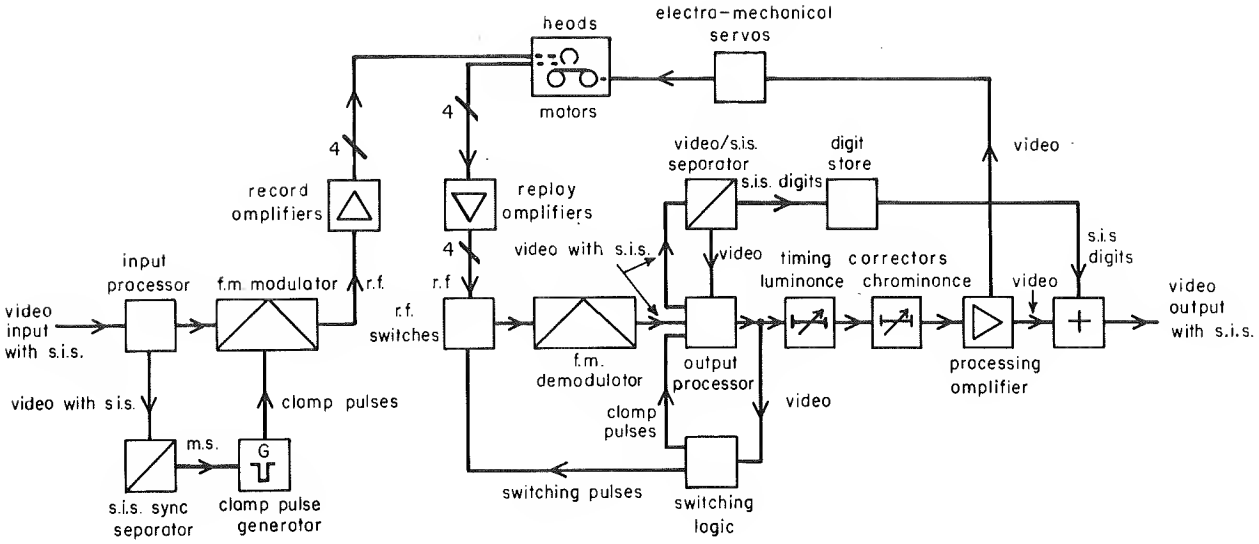

Fig. 3 - Typical quadruplex videotape recorder, incorporating the proposed modifications to handle sound-in-syncs signals

and indicates the special synchronising-pulse separator associated with the recording clamp-pulse generator.

During replay, the digital S-i-S signal is extracted in the video/S-i-S separator and passed to a conventional shift-register where it is stored temporarily; the composite signal (video with S-i-S) is reconstructed by adding back to the video signal the stored (delayed) S-i-S signal after all the normal video signal processing is complete.

It was not found practicable to use a conventional S-i-S unit to extract the S-i-S component from the replayed signal, because of the irregular signal-timing and the problems of clock synchronisation that this would cause. Signal timing is usually stabilised by the variable delay units in the timing correctors but, in this application, timing-correction cannot take place until after the S-i-S pulses have been removed, for the reasons described in Section 2. At the extraction point, therefore, the signal may have line-by-line timing irregularities of the order of 0·5 μsec p-p, even when the recorder is operated in the 'Auto' or 'Horizontal' replay modes.

4. Practical work

Experimental equipment was constructed on the lines described in Section 3. Standard S-i-S synchronising-pulse separators were used, both to provide synchronising-pulses for the f.m. modulator clamp-pulse generator and to derive gating pulses in the Video/S-i-S separator. Separation of the video and S-i-S signals was accomplished using a video switch which operated for the periods occupied by the S-i-S pulses, leaving the video signal free from pulses. The digital store was a shift-register, into which S-i-S digits were fed serially using clock-pulses regenerated from the S-i-S marker digit (this is a standard technique used elsewhere in S-i-S equipment[2]). The S-i-S digits were read out serially using stable clock-pulses derived from output line-synchronising pulses.

The complete signal was reconstituted simply by adding the retimed S-i-S digits from the shift-register to the timing-corrected video signal. Using these modifications it was found possible to operate the video-tape recorder normally. Both recording and replay were possible and there was no interaction between the video and the S-i-S signals. The S-i-S sound signal was recovered using a prototype decoder without full error concealment and an audio recording was made of S-i-S recovered audio and conventional video-tape audio for comparison purposes.

5. Problems arising from practical work

Two main problems arose during the practical work:

(i) Synchronising-pulse separation

Conventional synchronising-pulse separators* were not designed to operate in conditions of erratic signal-timing (as found at the point of video and S-i-S pulse separation). Using such a separator, errors were evident every few seconds, usually resulting in the delivery of very narrow synchronising-pulses at the output. The most likely explanation of this effect was that the circuit mistakenly used the S-i-S marker bit as a synchronising-pulse (trailing edge).

Such faults resulted in failure to remove the S-i-S pulses from the video signal, their presence adversely affecting the video-signal timing-correction processes and even occasionally causing the mechanical servos to be momentarily unlocked. A second effect was also apparent due to the missing pulses from the S-i-S output of the separator, giving the usual 'click' disturbance.

*e.g. BBC UN16/516

(ii) Tape 'dropouts'

Tape dropouts caused further impairment of synchronising-pulse separation within the video/S-i-S separator. This was because the dropouts caused the generation of spurious synchronising-pulses by the synchronising-pulse separator, resulting in similar effects to those described above.

Only conventional dropout-compensators were available for the tests and these were found to be of little help with this problem. On the one hand, with one type of dropout compensator, instrumental difficulties allowed residual dropouts to remain in the video signal; on the other hand, correction had, of necessity, to take place at a point in the video signal path 'downstream' from the Output Processor, and, hence, too late to protect the video/S-i-S separator.

6. Possible future improvements

(i) A new synchronising-pulse separator is required, to operate in conditions of erratic signal timing such as exist at the point of video/S-i-S separation.

(ii) A suitable error-concealment method must be developed. It was not possible to test the error concealment methods used in later models of the S-i-S decoder, which are partly digital and partly analogue; however a technique such as is used in high-quality pulse-code modulation systems[4] and also the later S-i-S decoders could be used. Simply, this method stores each data word as it arrives, and holds it until the time when the next data word should have arrived. If, by this time, a good data word has not arrived, the stored word is re-used, thus partly concealing errors. This method is capable of improving the permissible error rate by up to 30 times (i.e. for an error rate of 2×10^{-5}, which gives just perceptible sound disturbances, the protection method enables the tolerable error rate to be relaxed to about 7×10^{-4}). It is thought that this order of protection would suffice for the S-i-S application.

7. Conclusions

The results so far obtained from the practical work have been very encouraging. It has been shown that the technique for separating the video and S-i-S signals, separately processing them and reconstituting the combined signal at the video-tape recorder output can work satisfactorily. Further work (as described in Section 6) is needed, however, before it can be established whether or not a satisfactory, reliable S-i-S system can be operated on a video-tape recorder.

8. References

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3. BBC Research Department Report 1969/52: a p.c.m. sound-in-syncs distribution system: combination and separation of sound and video signals.

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